

Massachusetts Institute of Technology  
July 14-25  
Summer Session 1969

# Programming Linguistics



In spite of an alarming proliferation of new programming languages over the last few years, language design continues to be more of an art than a science. Nonetheless, an embryonic science of programming linguistics seems to be emerging.

Typical questions to which such a science must provide answers include the following:

What are the basic underlying ideas involved in the specification of algorithms? Examples of such ideas include the application of functions to arguments, data types, data structures, variables (along with their declaration and storage assignment), updating, and transfer of control.

What tools are there for building large semantic constructs out of small ones? Examples are functional composition, the specification of new functions and values in terms of available ones, and successive execution of one statement after another.

How can different programming languages be compared? Needed are a set of coordinates along which both the syntax and semantics of programming languages can be measured.

How can the semantics of programming languages be presented in a meaningful way? The two traditional answers — specification by manual and specification by compiler — are not particularly satisfactory. There are then two goals: to be able to specify semantics exactly, and to do so in a way understandable by a human audience.

Completely satisfying answers to each of these questions are not yet at hand. Nevertheless, results of recent research at M.I.T. and elsewhere lend credence to a belief that such answers should be forthcoming soon. Specifically, research at M.I.T. has proceeded in two directions:

towards attaining a suitable conceptual framework for formalizing the semantics of programming languages

towards packaging the results in a pedagogically sound form for teaching sophomores who anticipate a major professional interest in computer science.

One major part of the effort has centered around the development of a programming language, PAL, whose objective is to illustrate relevant linguistic facilities. The second effort, formalizing PAL's semantics, permits demonstration of the conceptual framework and isolation of linguistic design alternatives. The research and teaching objectives have gone hand in hand.

## Outline of the Program

Three major threads will be followed throughout the summer Program:

development of theoretical foundations

formalization of PAL semantics in terms of the theory

exemplification of PAL's linguistic facilities through programming exercises

The branch of mathematical logic underlying much of PAL — Church's lambda calculus — will be considered first, along with an efficient evaluating mechanism for lambda expressions (the CSED machine, after Landin). A large subset of PAL, including all the definitional facilities, will then be developed as a humanized representation (syntactic sugaring) of lambda expressions. The evaluating mechanism, with algorithms for translating PAL into lambda expressions, will form the basis for semantic formalization.

Further developments will follow two directions. First, insight into the structure of PAL will be achieved by simulating the evaluating mechanism on the blackboard, and extending the mechanism to accommodate the "imperative" linguistic facilities of assignment and transfer of control. Second, since blackboard evaluation is informal, a gedanken interpreter, called the CSED machine, will be defined. Specification of this interpreter will complete the formalization of PAL semantics.

Additional lines of development will help tie this abstract formalization to reality. Participants will have the opportunity to write PAL programs and to run them on a time-shared computer. Finally, a series of lectures will consider how the linguistic concepts exemplified in PAL show up in other languages, and how alternative design decisions affect the semantics of a language. The Program will conclude with a brief survey of topics for further research.

The Program will be aimed at two specific audiences: the computer science professional concerned with the theory, design, and implementation of programming languages, and the college educator concerned with teaching computer science majors the conceptual underpinnings of the discipline. Although familiarity with no particular programming language is assumed, attendees should be competent in one or more high-level languages. There is no prerequisite in mathematics or math logic beyond the level of sophistication compatible with a year or more of college mathematics.

The format of the Program will be three lectures each day, two in the morning and one in the afternoon. In addition, there will be recitation sections and laboratory sessions to use the computer.

Tuition is \$450, due and payable upon notification of admission. Academic credit is not offered.

## Staff

Primary lecturers for the Program will be Professor Arthur Evans Jr. and Professor Robert M. Graham, both of the M.I.T. Department of Electrical Engineering and M.I.T. Project MAC, and Professor James H. Morris, of the University of California at Berkeley. Lectures will be given also by Professor John M. Wozencraft of the M.I.T. Department of Electrical Engineering and Lincoln Laboratory, and by Christopher Strachey of Oxford University.

The Program will be under the direction of Professor Evans.



## Special Summer Programs

### Beginning Tuesday, June 17

Computer-Aided Urban Design	4.70s
Infrared Spectroscopy: Technique*	5.16s
Industrial Dynamics	15.21s

### Beginning Monday, June 23

Multistory Steel Building Technology*	1.55s
Non-Destructive Testing*	2.14s
New Developments in Modeling, Analysis, and Simulation of Engineering Systems	2.22s
Electronic Materials — Growth and Characterization	3.80s
Infrared Spectroscopy: Applications*	5.17s
Speech Communication	6.69s
Forecasting with Econometric Models	14.38s
Mathematical Programming	15.59s

Recent Advances in the Biomedical Sciences Pertinent to Oral Surgery\*

### Beginning Monday, July 7

Recent Developments in Mechanical Vibrations	2.04s
Strain Gage Techniques: Lectures*	2.12s
Detection, Estimation, and Modulation Theory: Part I*	6.52s
Recent Advances in Radio Astronomy	8.98s
Statistical Method in Modern Experimentation	14.37s
Frontiers in Investment Management and Analysis	15.42s
Management of Research and Development	15.90s

### Beginning Monday, July 14

Strain Gage Techniques: Laboratory*	2.13s
Programming Linguistics	6.23s
Detection, Estimation, and Modulation Theory: Part II*	6.53s
Semipermeable Membranes	10.67s
Management Science in Marketing	15.84s
Thermionic Energy Conversion*	22.98s
Nuclear Power Reactor Safety: Part I*	22.94s

### Beginning Monday, July 21

Application of State-Variable Techniques to Communication Systems*	
Theory and Design of Optimal Linear Control Systems*	

Models for Financial Management and Long-Range Financial Planning

Nuclear Power Reactor Safety: Part II\*

### Beginning Monday, July 28

Computer Applications in Naval Architecture and Ocean Engineering	
Nuclear Power Reactor Safety: Part III*	

### Beginning Monday, August 4

The Electron Microanalyzer and Its Applications

Display Technology

Fermentation Technology\*

### Beginning Monday, August 11

Planning and Control of Ship Production Processes

Management Information Systems

Engineering Aspects of Aerospace and Undersea Medicine

Beginning Monday, August 18  
Prediction and Measurement of Stresses and Deformations in Soils\*

Physical Measurement and Analysis

Industrialized Building

Information Technology

Welding Fabrication in Shipbuilding and Ocean Engineering\*

Communicating Technical Information\*

### Beginning Tuesday, September 2

Planning and Control of Operations

Operations Research for Public Systems\*

### Beginning Monday, September 8

The Management of Human Resources\*

Programs marked with an asterisk (\*) are of one week's duration. All others will extend through two weeks.

## General Information

**Admission:** In order to maintain highest standards, the enrollment in each Special Summer Program is limited according to the facilities and staff which are available. If a Program is not over-subscribed, applications for it will be considered up to one week before it begins. However, early application is strongly advised. Application forms are available from the Director of the Summer Session, M.I.T.

The Institute reserves the right to select those applicants whose qualifications and experience suggest that they will receive the most benefit from the Program for which they are applying. Neither admission nor dormitory reservations are transferable except by specific Summer Session Office authorization, and then only when evidence of the qualifications of the proposed substitute has been filed in advance.

A limited number of Special Summer Program Scholarships are available to defray in part the Program tuition of members of teaching staffs (rank of instructor or higher) of other educational institutions. Request for such scholarships should accompany applications for admission.

**Payments:** Applicants whose admission has been approved will be notified as early as possible and will receive Bursar's remittance and registration cards. Both cards, together with full payment for tuition and housing in check, draft, or money order made payable to the Bursar, M.I.T., should be returned immediately to the Office of the Summer Session (Room E19-356, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139; they must be received one week before the opening of the Program. The amounts of tuition and room rent will be stated in the notification of admission; both may be included in one remittance, and both must be paid in full before the opening session of a Program. No bills are sent.

Those whose tuition is to be covered by contract with a government agency or with industry should apply for admission to the Summer Session Office in the usual way, as promptly as possible, noting on their applications that a contract or agency approval is being requested. At the same time they should arrange to have the *agency* send a purchase order or other evidence of its intention to authorize tuition payments to the Summer Session Office. This purchase order should reach the Summer Session Office at least one week before the Program begins. It should include the full name of the prospective registrant(s), as well as the name of the Program. If it is not sent, and if the Program is

a limited one for which others have applied, the Institute reserves the right to cancel admission.

Since housing charges (if any) are not covered by government contracts, these payments must be received independently from prospective registrants at least one week before the beginning of a Program.

Please note that a contract from industry or a government agency does not reserve a place in a Special Summer Program; it must be preceded or accompanied by a completed application for admission.

**Refunds:** Registrants who notify the Summer Session Office of cancellation of their plans before they arrive in Cambridge will be refunded their payments. However, no refunds of either tuition or rent will be made to those who leave before completing a Program in which they have been registered, and refunds of room rentals cannot be made for Saturdays, Sundays, or holidays during a Program.

**Registration:** Each person admitted to a Program should report to the main lobby of the Institute at 77 Massachusetts Avenue, Cambridge, at 8:30 a.m. on the day that his Program begins. At this time he completes formal registration, receives a receipt for payments, and is given cards of admission to the Program. Detailed information about special M.I.T. facilities and services will also be available.

**Mail and Messages:** Registrants for Special Summer Programs may have mail and messages addressed to them at the Summer Session Office. Please have the name of the Program included in the address.

**Dormitory Accommodations:** The M.I.T. dormitories will be available to all registrants in Special Summer Programs. Rooms for single men, as well as accommodations for married couples and single women, will be reserved if specifically requested in the application for admission. Applicants who wish other accommodations should correspond with Boston or Cambridge hotels.

The rate in an M.I.T. dormitory for single men and women is \$7.00 and for married couples \$10.00 for each 24-hour unit, beginning at 6 p.m. Children between the ages of 6 and 14 may be accommodated at the rate of \$3.00 per night. There is no reduction in rate if these children occupy the same room as their parents. Children 15 years or over are charged at the rate of \$7.00 per night. In general,

reservations will be available from 2 p.m. of the Sunday preceding the opening of a Program until 6 p.m. of the Saturday following its conclusion. Dormitory accommodations will not be available until noon on Tuesday, June 17, for Programs commencing that week. Dormitory reservations will be confirmed in the letter of notification of admission; this letter should be presented at the dormitory upon arrival. Please include payments for dormitory accommodations with tuition payments; both are due at least one week in advance. *Registrants in Special Summer Programs should make no rent payments at any dormitory office.*

N.B. Bed linen and towels are supplied. Dormitories do not have air-conditioning or private baths. Rooms for men and women may be on the same floor.

Each dormitory is open 24 hours every day. Children under six years of age may not be housed in any dormitory during the Summer Session, nor are pets allowed. No dormitory employee is authorized to modify these regulations.

College dining facilities on the campus will be available to Special Summer Program registrants and their guests. Registrants will enjoy guest privileges at the air-conditioned M.I.T. Faculty Club. In addition, there are restaurants within walking distance of the Institute, and many famous eating places and hotels are situated just across the Charles River in metropolitan Boston.

**Recreational Facilities:** Summer guests are welcome to use the Institute's libraries and recreational facilities, including tennis courts, softball fields, squash courts, swimming pool, and fleet of small sailboats.

Within easy access of the Institute campus are some of the world's finest museums, libraries, and art galleries. The famous Hatch Memorial Shell, outdoor summer concert hall for the Boston Pops Orchestra, is just across the Charles River Basin. Major League baseball games are scheduled throughout the summer at Fenway Park, only a short ride from the campus. Several summer theaters and the historical areas of Salem, Concord, Lexington, and Plymouth are within easy driving distance, and Cape Cod, the White Mountains of New Hampshire, the Green Mountains of Vermont, and many parts of the Maine seacoast may be visited on weekends.